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WATER QUALITY AND FISHERIES ISSUES ACCOMPANYING POPULATION GROWTH IN THE PHILIPPINES*

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INTRODUCTION

The Philippines with its over 7,000 islands is primarily a coastal country. Eighty-two percent of the provinces and 65 percent of the municipalities border the coast. The country's exclusive economic zone (EEZ) covers 200 million ha. The marine flora and fauna in these waters are one of the most diverse in the world. There are 2,400 species of fish, several hundreds of which are of commercial value. Shelf areas (0-200 m deep), comprising 225,000 sq. km. (or 13.5 percent) of marine waters, are the most productive due to the accretion of organic matter from land. Inland waters consist of swamplands (106,328 ha), lakes (200,000 ha), rivers (31,000 ha) and reservoirs (19,000 ha). Approximately 260,000 hectares are used for aquaculture, with brackishwater making up 81 percent of the total area.

The Philippines is a major fishing country belonging consistently to the top 20 in the world in terms of production. In 1993, value added in the fishery sector was ₱ 56.9 B in current terms (NSCB 1993). Fishery output was 18 percent of the total output in agriculture, fisheries and forestry subsector, or 3.8 percent of the gross national product (GNP) at current prices. Leading fishery exports in terms of value in the same year were shrimp/prawn, tuna, cuttlefish/squid, and seaweeds. Based on the latest available census in 1980, direct employment was estimated at 1 million fishers and fishfarmers. Given the country's high

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population growth rate, the generally open-access condition of fisheries exploitation, and the excess labor supply this number has most likely increased, increasing pressure on water and fishery resources.

Water and fishery resources are vital to the country's economy and culture, hence their proper use is of utmost concern. However, increasing demands on these resources, primarily from population growth and economic development, endanger the sustainable flow of goods and services they provide. The objective of this paper is to identify the consequences that population growth imposes on these resources in the context of population-development-environment modeling. Specifically, the major issues that should be dealt with by such a modeling effort are raised.

FRAMEWORK FOR THE REVIEW OF ISSUES

The identification of issues follows from the conceptual framework illustrating population-related factors that determine water quality and the status of fishery resources. For water quality, the typical water systems technology illustrated by Rogers (1993) are modified and expanded to show the impacts of population on water quality. Users would include households, but this sector is segregated and its scope is widened to population as a whole. It would be primarily industry, commerce and other services whose level of activities are determined by human population. The impact is manisfested through increase in demand for goods and services from population growth, incomes or a combination of them. Incremental household wastes entail additional demand on the wastewater disposal system. From the figure, we can surmise that the impact of population growth on water quality may be both direct (disposal of household wastes) and indirect (impact on industry and commerce).

The impact of population growth on fishery resources can be traced to two factors, namely, pollution from the disposal of wastes and increased fishing intensity. These factors reduce the stock of fish or biomass. Fishing intensity arises from coastal in-migration and from the need to produce more fish to feed an increasing population. Coastal in-migration and the consequent increase in fishing intensity is contingent on the inability of other sectors to provide jobs to the growing labor force. Water pollution, which results from the discharge of wastes beyond the assimilative capacity of water bodies, reduces the ability of water bodies to support aquatic life, including fisheries.

REVIEW AND DISCUSSION OF ISSUES

From the framework, the issues pertaining to water quality and fisheries may be identified. Another excellent starting point in the identification of issues is the Philippine Strategy for Sustainable Development (PSSD), which enumerates the most pressing issues needing resolution to attain sustainable development. To a certaint extent the issues identified in the PSSD document may also proceed from the framework. This section we discusses some of these issues in detail and presents available empirical data.

Key issues pertaining to water quality identified in the PSSD are found in the sections on urban and freshwater ecosystems. In the first section, the two issues—pollution from industrial effluents and solid waste disposal by domestic, commercial and industrial establishments—are exacerbated by another identified issue, which is population migration to urban area. In freshwater ecosystems, the identified issues affecting water quality are pollution from domestic, commercial and industrial activities, agricultural runoffs from pesticides and fertilizers, siltation, and saltwater intrusion.

Key issues pertaining to fishery resources as identified in the PSSD's in the second section on coastal resources include the following: a) overfishing of nearshore areas due to expanding coastal population; b)continued wide-scale use of illegal fishing practices; c)degradation of coral reefs; d) disappearance and degradation of spawning areas, notably mangrove areas, due to conversion to fishponds and other uses; e)encroachment of commercial fishing vessels into nearshore areas reserved for small-scale fishers; and f)ineffective arrangements for regulating coastal and marine resources.

The PSSD also specifies the key measures needed to address a broader range of issues than those enumerated above. The measures identified in the sections on urban and freshwater ecosystems may address the issues pertaining to water quality and fisheries simultaneously or separately. These include the following:

- rationalization of current environmental and pollution policies;
- implementation of a pragmatic information and education campaign on the effects of air and water pollution and solid waste disposal;
- stringent enforcement of laws, ordinances, rules and regulations;

- implementation of a sound monitoring system;
- setting up of treatment plants for domestic wastes and wastes of similar industry types; and
- identification of point and nonpoint sources of pollution.

The recommended measures in the section on coastal resources also address issues specific to fisheries:

- containment of oil slicks;
- control of siltation by reforestation;
- granting of exclusive rights to small fishers;
- stepped-up enforcement of fishing laws and zoning rules;
- common property management arrangements, i.e., assigning and developing common property rights to coastal communities or fisher organizations in the use and protection of coastal fishing rights;
- preparation of site-specific fishery resources management plans based on the inventory of resources and assessment of sustainable fishing yields;
- rehabilitation of coastal resources (coral reefs and mangroves) to sustain fish yields, including measures to enhance productivity through artificial means, e.g., artificial reefs; and
- provision of alternative livelihood opportunities for coastal communities to reduce reliance on fishing as a source of income.

Issues pertaining to water quality

The issues pertaining to water quality are primarily regional or location-specific. Deterioration of water quality may be observed in greater intensity in urban areas than in rural areas. To a certain extent, water quality problems are specific to the type of water body. Surface waters like lakes and reservoirs are prone to eutrophication and sedimentation. Groundwater, on the other hand, is more susceptible to agricultural pollutants, such as fertilizers and chemicals. Water quality also tends to vary temporally (Nash 1993). Consideration of water quality depends on how water is used; Table 1 describes current water usage and classification. Drinking water requires the highest quality. Other uses of water require progressively less quality, such as for recreational use (e.g., swimming), industrial use, and irrigation. However, certain uses require lower concentration of certain parameters, such as those for industrial uses. The ability of water bodies to support aquatic life entail different demands on water quality given the greater sensitivity of aquatic species to organic and chemical pollution compared with humans. The following discussion of issues, therefore, has an underlying geographical or regional focus as well as temporal considerations. To simplify the issues, there was no attempt to establish links between water quantity and water quality, although these two considerations are entertwined, particularly in situations of water scarcity.

TABLE 1. Water Usage and Classification for Fresh Surface Water

Classification	Beneficial Use
Class AA	Public Water Supply Class 1 which requires only approved disinfection in order to meet National Standards for Drinking Water (NSDW).
Class A	Public Water Supply Class 2 which requires complete treatment (coagulation,sedimentation, filtration and disinfection) in order to meet NSDW.
Class B	Recreational Water Class 1 for primary contact recreation such as bathing, swimming, skin diving, etc. Designated for tourism purposes.
Class C	Fishery Water for the propagation and growth of fish and other aquatic resources; Recreational Water Class 2 for boating, etc.; and Industrial Water Supply for manufacturing processes after treatment.
Class D	For agriculture, irrigation, livestock, watering, etc. Industrial Water Supply Class 2 for cooling, etc.

Increasing pollution and damages from pollution

Water bodies have been used as sinks for human and industrial wastes due to their ability to help break down wastes and return them into their natural environments. Increasingly, however, the natural capacities of water bodies for waste processing have been exceeded and eventually reduced by excessive pollution loads. The latest monitoring of rivers indicates that over half of the rivers in the Philippines have water quality of class C and D; 35 percent, class A; and 12 percent, class B (Table 2). The regions with the worst classification are the National Capital Region and Regions 2, 3, 4, 5 and 8, while the more pristine rivers are found in Region 10.

TABLE 2. Classification of Rivers, 1995

Region	A		B		C		D		Total
1	7	(47)	2	(13)	6	(40)	0	(0)	15
CAR	4	(28)	4	(28)	6	(44)	0	(0)	14
2	1	(5)	2	(9)	14	(67)	4	(19)	21
3	11	(26)	4	(10)	26	(62)	1	(2)	42
4	11	(23)	3	(6)	1	(2)	33	(69)	48
5	7	(38)	1	(6)	9	(50)	1	(6)	18
6	11	(35)	7	(23)	13	(42)	0	(0)	31
7	4	(40)	3	(30)	3	(30)	0	(0)	10
8	1	(50)	0	(0)	1	(50)	0	(0)	2
10	25	(89)	0	(0)	3	(11)	0	(0)	28
12	0	(0)	2	(50)	1	(25)	1	(25)	4
NCR	1	(17)	0	(0)	5	(83)	0	(0)	6
Philippines	**83**	**(35)**	**28**	**(12)**	**88**	**(36)**	**40**	**(17)**	**239**

Figures in parentheses are percentages to row total.
Source of basic data: Updated list of Classified Rivers and Bays, EMB (January 1995).

In the Philippines, wastes from households, industries and agribusiness have polluted rivers, lakes and oceans. Urban, rural and upland runoff has caused sedimentation. The deterioration of water quality has negatively affected human and aquatic life, and posed problems for water users. Pollutants have impaired ecological stability and the primary production of water bodies which are indicators of their ability to support aquatic life. Pollution, to a certain extent, has increased water temperature, resulting in excessive algal growth which has affected other forms of aquatic life. Moreover, the deterioration of water quality has rendered it unfit for human and industrial uses, requiring substantial processing costs to transform it to an acceptable quality.

Discharges of water pollutants in the Philippines are presented in Table 3. The household sector accounts for a large portion of BOD_5, suspended solids, nitrogen and phosphorus. Sectors or industries whose level of output are directly related to population—e.g., commercial, social and personal services sectors—have significant discharges of water pollutants. What is missing in the table is the distribution of the impact or pollution level on specific water bodies.

TABLE 3. Water Pollution Discharges in the Philippines, 1988 (metric tons)

Industry	BOD_5	Suspended	Total Solids	Oil Dissolved Solids	Nitrogen	Phosphorus
Agriculture, Forestry, Fishery						
Agricultural Crops					257,282	5,184
Livestock Production	906,691	4,478,751	0			
Forestry					791,090	21,572
Mining and Quarrying		2,263,357	0			
Manufacturing						
Food, beverages, tobacco	200,170	179,932	1,022,883	38,151	22,340	0
Textile and leather	25,692	14,207	36,166	455	341	0
Wood products	4,500	792	333			
Pulp, paper, paper board	11,201	16,342	56,850			
Industrial chemicals	6,893	2,622	0	1,030	380	0
Non-metallic mineral	0	2,379	19,190	0	0	0
Basic metal	441	1,771	0	0	0	0
Fabricated metal products	0	12,414	8,969	1,104	0	0
Electricity, Gas and Water	11	144,978	533	1	0	0
Wholesale and Retail Trade	4,089	20,195	0	0	0	0
Commercial, Social, Personal Services	5,904	5,026,023	0	248,768	54,438	11,423
Households	1,092,646	1,092,646	0	0	174,823	29,137
TOTAL	**2,258,237**	**13,256,418**	**1,144,924**	**289,419**	**1,506,971**	**67,317**

Source: Orbeta (1994).

This information is available, so far, for Laguna de Bay in 1990, which is shown in Table 4. The most significant sources of water pollutants are community wastes, particularly domestic (household) wastes, which account for over 40 percent of phosphorus, about 50 percent of BOD_5 and nitrogen, and almost all of total dissolved solids. The projected pollution loads in the lake for the years 1995 and 2000 are directly linked to population growth and to industrial expansion.

TABLE 4. Estimated Pollution Loads in Laguna Lake, 1990 (metric tons)

Pollutant	Domestic	Urban Run-off	Fertilizer Run-off	Industries	Agri-business	Total
BOD_5	38,530	4,160	23,065	12,713	78,468	
% to total	49.10	5.30		29.39	16.20	100.00
Suspended solids	31,611	33,520		49,336	70,793	185,260
% to total	17.06	18.09		26.63	38.21	100.00
Nitrogen	7,039	672	1,600		3,944	13,255
% to total	53.10	5.07	12.07		29.75	100.00
Phosphorus	1,384	112	310		1,314	3,120
% to total	44.36	3.59	9.94		42.12	100.00
Total dissolved solids	39,998				62	40,060
% to total	99.85				0.15	100.00
				1.41		1.41
Oil				100.00		100.00

Source: de los Angeles and Pabuayon (1994).

Directly resulting from pollution are the damages imposed on water users. Table 5 lists the estimates of damages from water pollution in the Philippines. The largest accrues from off-site damages from the sedimentation of coral reefs and reservoirs. It follows that with the increasing deterioration of water quality, pollution damages would also escalate. The feedback to population through health costs are, however, minimal. Another cost of pollution is the more frequent occurrence of "red tides," which has been partly attributed to pollution. The economic and social costs in terms of foregone earnings from sale of shellfish in affected areas and the loss of livelihood by fishfarmers and gatherers are quite high.

Table 5. Estimate of Damages from Water Pollution, 1988

Nature of Damage	Amount of Damage (in PM)
1. Health	84.0
Cost of persondays lost from morbidity change	14.7
Cost of medication	44.5
Cost of premature death	24.8
2. Off-site damage	2,423.0
a. Coral reefs	1,851.5
Fisheries	
Municipal	744.4
Commercial	513.6
Tourism	593.5
b. Reservoirs	
Magat dam	44.8
Pantabangan dam	1.1
Ambuklao dam	6.6
Binga dam	5.3
c. Agricultural production	
National irrigation systems	
Wet season crops	239.7
Dry season crops	160.4
Communal irrigation systems	
Wet season crops	14.2
Dry season crops	10.8
d. Fisheries (Laguna de Bay)	88.6
TOTAL	**2,507.0**

Source: Ebarvia (1994).

Increasing population growth, urbanization and poverty

The impact of population growth, urbanization and poverty on water quality are covered explicitly or implicitly in the estimates of pollution loads and costs of pollution. These factors are discussed separately here to underscore their contribution to the deterioration of water quality and the consequent impacts of water pollution on human health.

Population growth has been concentrated in urban areas, most of which are situated in coastal zones. Some of the largest and relatively densely populated urban centers—such as the metropolitan areas of Manila, Cebu, and Cagayan de Oro—are all located in the coastal zone. Worldwide, coastal population is 42.7 percent, and this is projected to increase to 60.5 percent in 2025 (Harphan and Stephens 1991, as quoted by Nash 1993). In the Philippines, over 70 percent of the people live within 10 km of the coast and 75 percent of settlements are considered coastal. In Metro Manila, increasing urbanization overloaded water and sewerage facilities, which have been designed for a much smaller population.

Water quality and poverty are somehow linked. Squatter colonies which mushroomed along critical waterways in Metro Manila have restricted the free flow of water. This, or the stagnation of water in certain areas and the more frequent occurrence of flash floods, compounded pollution problems. The other side of the issue is the vulnerability of the poor to the negative health impacts of deteriorating water quality by directly exposing themselves to waterborne diseases (e.g., diarrhea and hepatitis A). Moreover, the poor have the least means to protect themselves against pollution and its consequences.

Control of water pollution

The control of water pollution is limited for pollutive industries and sectors. Wastewater treatment facilities for household or domestic effluents in Metro Manila are limited to physical treatment, i.e., separation of solids in settling ponds or in communal septic tanks and discharge of the liquid wastes into Manila Bay. A survey of establishments conducted by the Environmental Management Bureau and its predecessor, the National Environmental Pollution Council, which covered an average of about 5,700 establishments per year from 1980 to 1987, indicates that about 15 percent of these establishments contribute to water pollution. Of the pollutive establishments, 70 percent have a wastewater treatment facility. This control rate may appear high, although for small-scale establishments and households, which account for a large portion of pollutants, the extent of water pollution control is minuscule.

As discussed in Orbeta (1994), the typical wastewater treatment facility targets the removal of suspended solids and organic dissolved solids. The primary treatment involves screening, grit removal, skimming, and sedimentation, which can remove up to 35 percent BOD and 65 percent suspended solids. The secondary treatment includes chemical coagulation, high rate trickling filter, low rate trickling filter, activated sludge, extended aeration, aerated lagoon, and waste stabilization. These collectively remove up to 98 percent of BOD and 92 percent of suspended solids. It is not clear, however, if the typical wastewater treatment facility employs the above treatment processes.

The usual approach to address water problems (e.g., scarcity and deterioration of water quality) as indicated above is the construction of more or bigger facilities which are either funded directly by government or indirectly through subsidies or incentives. These approaches are technical fixes. A technical fix is the response to crisis brought about by failure or misuse of technology, which is fixed by some other application of the same or different technology (Rogers 1993). In the Philippines, the current water crisis and continuing degradation of water quality point to the need for more technical fixes in addressing water-related problems.

An alternative approach to address water problems is the use of system fixes which may provide a better response in the reduction of wastes or demand management by rationing or pricing. While system fixes are generally inexpensive, they require social adjustments and may not be politically acceptable. Water and its environmental services are not priced appropriately in the Philippines. These situations, however, provide alternatives to technical fixes in addressing water quality issues. One example is effluent pricing, where the polluter is assessed a tax for every unit of effluent discharged to the environment. This is the polluter pays principle. Another example involves market-based solutions, e.g., pollution permits that may be sold which would internalize the externalities of water pollution. In this case, the level of pollution is left to market forces. Variations of effluent pricing have been implemented in other countries, e.g., in the U.S., where sewer charges were assessed on residences and industries based on their water consumption. The feasibility of this regulation may be worthwhile investigating in the Philippines. An attempt has started in Laguna Lake and the results are being closely watched.

Interrelationships between water quality, air quality and waste disposal standards

Standards for water quality may not be set independently of standards for air quality and other environmental media. Water quality is obviously affected by water-borne and airborne wastes which ultimately find their way into water bodies. Standards covering water and air quality should, therefore, be set, taking into account their interrelationships and the impact of related regulations, such as those on waste disposal. A relevant issue here is the purposes of setting acceptable water quality or waste disposal standards. Is the goal of improving water quality for the improvement of public health, environmental health, or both? While both should be the objective, they require varying levels of standards or requirements and, consequently, entail different costs. Ultimately, the question of the benefits net of costs would dictate the acceptable standards in all cases.

Issues pertaining to fisheries

Increasing demand-supply gap in fish products

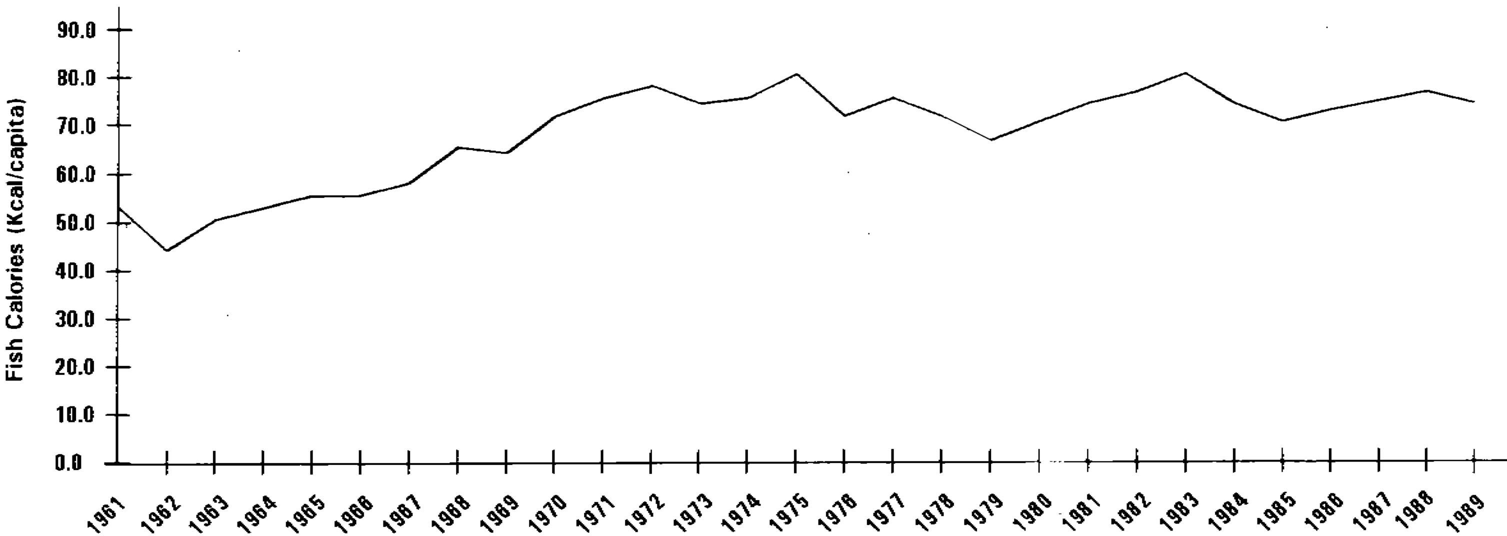
The supply of fish is a primary concern in a country where fish is the cheapest source of animal protein and where per capita consumption is high. Although total fish production has been generally increasing, the rate of increase has been declining. Over the last three decades, from 1962 to 1991, the average annual increase was 5.2 percent which is lower compared to 1962-1991 (8.5 percent) but higher compared to 1972-1981 (3.4 percent) and 1982-1991 (3.5 percent). Fig. 1 shows the per capita consumption of fish as a function of population from 1961 to 1990 using data from Food and Agricultural Organization (1993). The increasing trend is from the early years due to the rapid increase in fish production. After reaching a peak of 81 kilo-calories per capita in 1975, fish intake became erratic and dependent on fish production. International trade in fish and fishery products may have supplemented local production but fell short to maintain the peak level of consumption.

Considering the certainty of growth in demand for fish arising from population and economic growth, and the uncertainty of increase in fish supply, scarcity of fish and fishery products is inevitable. As will be shown, matching local supply to increasing demand has the tendency to reduce sustainable harvests under certain circumstances. The supply side of the scarcity equation may be attributed to the factors enumerated below which directly or indirectly emanate from population growth.

1. **Overfishing**

Biological overfishing occurs when the rate of harvesting exceeds the rate of renewal; in which case, there is "mining" into the parent stock. Overfishing may increase harvests in the short run but results in a) lower biologically sustainable harvests in the long run and, b) smaller average size of fish caught. Studies of Philippine demersal (bottom-dwelling) species and pelagic (surface-dwelling) species indicate that the reported catches hover around the respective estimated maximum

Figure 1. Per Capita Fish Consumption, Philippines, 1961-1990



sustainable yields (Silvestre and Pauly 1987; Padilla and de Guzman 1994). However, an indication of overfishing is that these catches are harvested by a much larger number of fishing vessels and fishers, with the catch per unit of effort on the decline (Fig. 2).

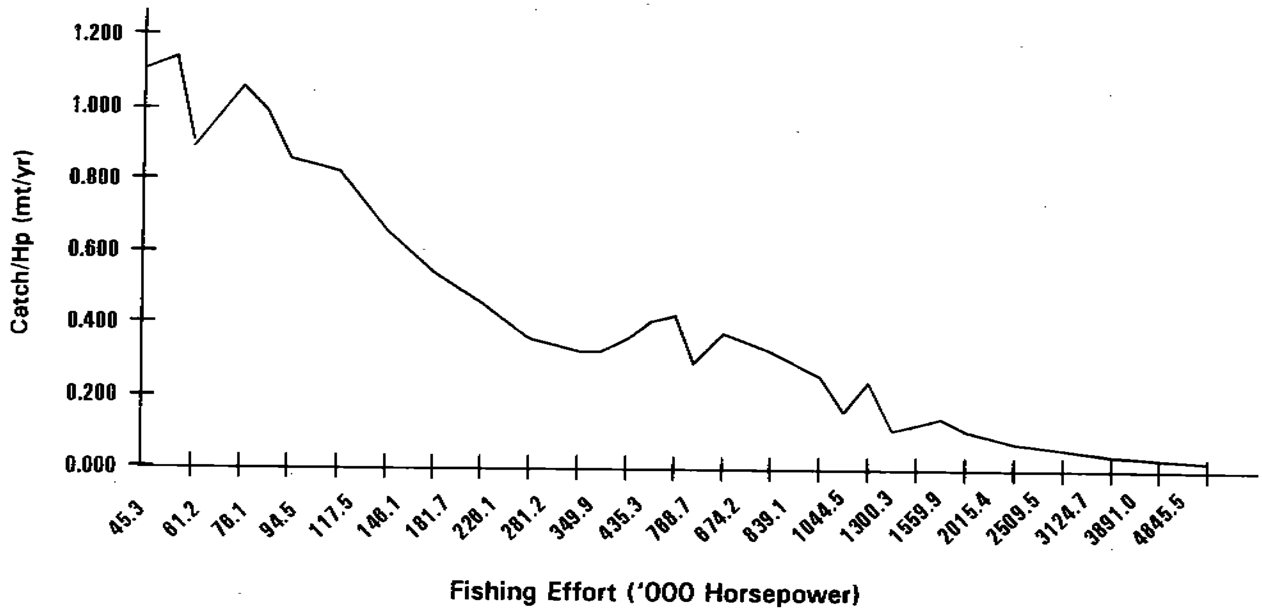
Comparing the current fishing capacity with that which corresponds to the maximum sustainable yield, the estimates of excess fishing capacity were 30 percent in the demersal fishery in 1984 (Silvestre and Pauly 1987) and 67 percent in the small-pelagics fishery in 1991 (Padilla and de Guzman 1994). A concrete observation indicating overfishing in specific areas in the Philippines was also made by Fox (1986) who stated that fishers in very high density areas (>70 fishers/km of coastline) have an average daily catch of about 1 kg/person-day, while fishers from average density areas (2-70 fishers/km) catch about 9 kg/person-day.

Fishery resources are natural resource assets for which the economic approach to utilization optimizes the stream of benefits generated over time. The economic approach which strengthens the biological prescription calls for a level of effort that gives the maximum economic yield both in the current and future periods. However, the Philippines tended to maximize the current contribution of the fisheries sector in the national income accounts by stressing immediate production. The expansion of fishing effort in the two fisheries dissipates the potential rents in these fisheries. Lower rents indicate that the pelagic and demersal fisheries are also economically overfished, that is, current levels of exploitation deviate from the economic optimum.

2. Common property resource exploitation

Fishery resources in the territorial waters of the Philippines and in its EEZ are primarily for Philippine nationals, except in isolated cases where access is granted to foreign fishing vessels and in the more common illegal poaching by foreign fleets. The result in the exploitation of the commons is well known as expounded by Hardin (1968). In a country with a high surplus labor, commons like the fishery resources have become the employers of last resort; thus efforts to rationalize their utilization by limiting entry have not been implemented aggressively due to potential high social costs. Given a scenario where the absolute number of unemployed increases with population growth and given the institutional setup of the fisheries' exploitation, the biological and economic status of the fishery will inevitably worsen.

Figure 2. Catch Per Unit Effort in Philippine Municipal Fisheries



On the policy side, enabling legislation, primarily the Local Government Code, has been enacted to pave the way for addressing the commons problem through a devolution of fisheries management to the local government units. The first and important step has been done, although much needs to be done towards rational resource use through the provisions of this landmark legislation. For instance, mechanisms should be in place to address serious overfishing on the one hand, and for fishing communities to assume resource management responsibilities on the other hand. Nevertheless, the political economy of the social consequences of fishery management is a primary issue to be addressed.

3. Poverty

Fishers, studies show, are one of the poorest occupational groups in Philippine society (Abrera 1976; Ardales and David 1986). Ardales and David reported per capita income for artisanal fishers in Iloilo province in 1981 of as low as P780 per year and a median income of P2,616 per year when the national figure for all sectors was about P6,500 per year. Average catches for small pelagic fisheries for the entire country have declined progressively from almost 0.9 to 0.2 ton per fisher per year from 1949 to 1991 (**Fig. 2**). Poverty may have been aggravated by some forms of assistance intended to solve this problem. As pointed out by Smith (1981), when resources are overfished, any form of assistance that increases fishing effort will reduce average catch rates and eventually will lower employment. Displaced fishers are then cast into poverty.

The study by Smith (1990) noted that in most fisheries where the stock is limiting (i.e., scarce), the distribution of catch (hence, income) is skewed towards larger and more efficient producers. Padilla and Trinidad (1992) also reported a duality in the socioeconomic conditions in fishing communities, whereby the more skilled fishers, primarily in commercial vessels, obtained much higher incomes compared with relatively unskilled fishers in artisanal crafts. The entry of marginalized labor into the fishery would likely decrease average incomes of small fishers and, hence, would worsen income distribution.

4. Government subsidies and protection

In the past, the fishery sector has been heavily subsidized and protected by import restrictions and tariffs on imported fish to protect producers, and, in some cases, tariffs on vessels and other fishing inputs to protect allied industries. Subsidies to the sector include lower cost of fuel for some fishing activities, lower interest rates for loans or outright grants for the construction of vessels, purchase of gear and the provision of support infrastructure such as ports, ice plants, freezers and marketing facilities. The fees imposed to gain access to fishery resources are minimal and bear no relation to the real value of net benefits privately appropriated compared with the captured benefits; these also constitute a subsidy. For instance, fees assessed on commercial fishing and the privilege to put up fixed fishing gear (e.g., fish corrals) are relatively small compared with the value of catch and the rents derived by the owners. There is a recent recognition, however, to impose user fees on exploiters of fishery resources with the conduct of the study on the economic rents from commercial fishing. However, the results of this study have not been disseminated.

The extensive recourse to subsidies in the past arose from government efforts to spur economic activity in the sector to maximize production, preserve or even increase employment in fishing and in related industries, and alleviate poverty among artisanal fishers (see, for example, Padilla and de los Angeles 1992). As accepted in economic theory, protection and incentives entail economic costs to the industry protected and to the economy as a whole. Shielding any industry from competition engenders inefficiencies. Incentives, on the other hand, encourage intensive resource use. For instance, financial incentives generally lower the costs of fishing, which, in turn, increase profits. Above-normal returns attract more fishers into the fishery; this dissipates profits in the long run unless restrictions to further entry are put in place.

5. Intensification in capture and culture fisheries

The race for a bigger share of the commons led to more intensive fishing, surpassing resource productivity limits in capture fisheries, as indicated earlier. (Table 6 compares the results of more intensive exploitation in terms of yield, revenue and rent for the small pelagics fishery, which supports the preceding arguments). In aquaculture, the drive for profits, coupled with many forms of incentives in the past, led to more intensive farming technologies. Given better control of operations in aquaculture, intensification may hold more promise in providing a more steady source of fish supply. However, as aquaculture competes for scarce resources such as water, land and other inputs, intensification in this sector is subject to certain limits. Some forms of intensive aquaculture have also caused environmental damages, such as soil subsidence and salt-water intrusion from excessive pumping of groundwater, as reported in Negros island. The excessive use of fertilizers and chemicals arising from overdependence of some aquaculture technologies on these factors posed risks to human and fish health in some areas. Hence, great care should be observed in the intensification of aquaculture.

Environmental degradation

The links between the water and fishery resources lie in the degradation of the environment. The deterioration of water quality is of concern for fisheries as the areas that are usually affected first and worst are critical fish habitats like mangroves, seagrass beds, coral reefs, estuaries, bays, rivers, lakes and swamps. These areas are the most productive, most ecologically diverse, and most important fish breeding and nursery grounds where 90 percent of the world's marine catch reproduce. Collectively, they provide over 50 percent of harvests in marine capture fisheries. Pollution and environmental degradation contribute to the scarcity of fish and fishery products. A discussion of these concerns in the present section on environmental degradation originating from fishing-related activities complements the earlier section on pollution.

TABLE 6. Values of Key Fishery Indicators at Open Access, MSY and MEY, Philippines Small Pelagics Fishery, (In 1988 prices)

	Open Acess	Maximum Sustainable Yield (MSY)	Maximum Economic Yield (MSY)
Fishing effort (HP)	537,900	294,000	261,600
Sustainable catch (tons)	457,000	573,000	569,000
Revenues (million pesos)	5,958	7,462	7,414
Rents (million pesos)	0	7,055	7,128

Source: Padilla and de Guzman (1994).

1. Destructive illegal fishing methods

All forms of perceived destructive fishing methods are banned in the Philippines. However, the illegal use of dynamite fishing and the use of poisonous chemicals are common fishing practices in the Philippines. Such practices are often confined to the artisanal subsector. Blast fishing destroys coral reefs, kill juveniles, and endanger the life of the user. However, small fishers are driven to such fishing methods as better catch rates are achieved, but only in the short run. In the commercial subsector, the pursuit of profits has also led to the employment of destructive fishing gear and techniques. Examples are the use of large-scale pelagic driftnets in the high seas and of muro-ami, which are now banned in the Philippines and in other countries.

2. Loss of intertidal areas from conversion

Conversion of mangroves for aquaculture and agriculture contributed to the loss in these ecosystems. Table 7 shows the negative relationship between fishpond and mangrove areas. In some cases, mangroves converted to fishponds which became unproductive for various reasons have been left idle or totally abandoned, although no estimate of the abandoned fishpond area is available. Reclamation of the coastal zone for commercial (residential and tourism facilities) and industrial (ports, harbors and industrial estates) purposes has also been ongoing in the Philippines, although only to a limited extent. An amendment to the Agrarian Reform Law allowing the conversion of public lands to aquaculture under certain conditions would certainly accelerate the loss of intertidal areas. While this may increase fish production, this amendment, when improperly implemented, would defeat the purpose in the long run. Loss of intertidal areas is of concern as these areas perform functions supportive of fisheries and produce goods and services of value to coastal communities.

CONCLUSIONS

The above issues, while not very exhaustive, broadly cover the concerns regarding water quality and fishery resources. It was argued that these concerns are linked more indirectly rather than directly to population growth. The deterioration of water quality may not be attributed directly to population or its growth rate but to activities that relate directly to it. For instance, the extent of water pollution is directly influenced by the quantity of wastes discharged, which is a positive function of population. In the case of fishery, the increasing scarcity of fish and fishery products is due to demand increases from population growth. The supply of fish is indirectly affected by population in the sense that an increase in demand, along with other factors, lead to

Table 7. Mangrove and Brackishwater Fishpond Areas (In hectares)

Year	Mangrove Area	Fishpond Area
1970	288,035	168,118
1971	286,650	171,446
1972	284,211	174,101
1973	258,895	176,184
1974	256,156	176,032
1975	254,016	176,032
1976	251,577	176,231
1977	249,138	176,231
1978	246,699	176,231
1979	245,000	176,231
1980	241,801	176,231
1981	239,382	195,832
1982	239,382	195,832
1983	234,504	196,269
1984	232,065	206,525
1985	226,673	205,001
1986	221,280	210,319
1987	143,522	210,458
1988	139,100	210,681
1989	135,700	210,681
1990	132,500	210,681
1991	129,200	225,002
1992	126,300	239,323
1993	123,400	261,402

Source: Forest Management Bureau; Bureau of Fisheries and Aquatic Resources.

more intensive fishing. In most fisheries in the Philippines, the level of fishing activity in at least the past decade has been mining into the parent fish stock, which would reduce its biological renewal capacity in the long run. With the eventual decline in fish supply, the supply-demand gap in fish products would likely expand. Given the nature of relationships among population, water quality and fishery resources, and the urgency of concerns or issues brought to fore, any study of population-development-environment interactions in the Philippines should include components pertaining to water quality and fishery resources.

The linkages between population growth and the status of the environment (e.g., water quality) and natural resources (e.g., fishery) need to be investigated in any effort to analyze population-development-environment interactions. In the Philippines, the processes of reviewing and further documenting the linkages are initiated in this paper. Available empirical data, although limited, have already given indications of the magnitude of these linkages in the case of fisheries. For water quality, the impact of population may be quantified for specific water bodies, as in the case of Laguna de Bay and Manila Bay. The overall situation points to the need for generating more information to clarify the issues earlier identified and, perhaps, to put these issues in better perspective.

The analysis and modeling of these linkages will provide systematic basis for anticipating and addressing existing and potential problems in the coastal resources and water quality as human population inevitably grows. Solutions to the issues and problems may be identified and evaluated using such models.

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